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WHAT ARE THE REAL VALUES AND FACTS OF SEED POTATO CERTIFICATION?

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Even though most of our certified seed programs are 25 or 30 years old and even though the average yield of potatoes per acre has doubled since 1920 we find ourselves still preaching about the necessity of producing certified seed potatoes and the necessity for planting certified seed. This would appear a little ridiculous, but it is true, nevertheless.

There are usually two sides to every argument or story. Those of us who are responsible for the official phases of certified potato production occasionally get partially carried away by the self-imposed importance of our own work and may fail to evaluate properly the advantages of growing certified seed. Yet without question it has a very definite value. The advantages of producing certified seed potatoes can be listed in three groups: (1) the value to the potato industry, including the commercial grower; (2) the value to the

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seed grower other than financial; and (3) the actual financial gain to the seed growers.

Point number 1 shows where the true value lies—with the potato industry. Although potato certification in most states is supported financially almost entirely by seed potato growers, the real advantage is gained by the commercial growers and dealers as well as the consumer. Certification helped to establish certain standards of type by supplying good seed; it helped to provide the markets with a plentiful supply by producing good yields. In our times of surpluses this may not seem to be an advantage, but had it not been for disease-free seed we would have had many years of scarcity. Leaf roll, mosaic and ring rot never could have been controlled without certification programs. Any one of these three diseases could have destroyed the potato industry if allowed to go unchecked. And all of them would have gone unchecked if it had not been for the unified action brought about by a certification program.

In the second group, the value other than financial to the seed growers, is also very important. We have in Colorado today several certified seed potato growers who annually sell little or no tagged seed but continue to enter and certify their potatoes because they feel they gain by so doing. Their reason for this, is that, by paying for and receiving the certification inspections, they keep abreast of potato diseases problems, study their fields more closely, clean their cellars better, and, in general, keep up with the latest trends in potato production. I am thinking particularly of one grower who produces one hundred or more acres annually. He has one of the highest average yields in the state, often attaining 400 100-pound sacks per acre. He seldom sells very much seed. He has stated that he would feel well repaid if he never sold a sack of seed, because a good seed program brought about by certification has made it possible for him to continually produce high yields, and that the cost of certification represents only a small part of the support he feels he owes to the seed program.

Thirdly, the actual financial gain to the seed grower—"How much is it worth in dollars to the certified seed grower?" Here we bump into considerable mystery. Few if any of our seed growers will admit that they have ever made any money growing certified seed compared with what they could have made by growing straight commercials. There is no proof available in regard to matters of this kind. The greatest evidence in support of financial gains is the long faces that result when we have to reject seed for certification. Sometimes this is a matter of pride, but often the mercenary side enters in, as it rightfully should. It is difficult to see how a grower could lose money when the cost of certifying is usually less than ten cents per sack. A very real value that has been pointed out by many seed growers is the increased value of small potatoes. There is no doubt that the potatoes ranging from $1\frac{1}{2}$ to $2\frac{1}{4}$ inches in diameter are worth a great deal more as certified seed than

they would be on the commercial market. Also in Colorado this year the average yield per acre for certified seed potatoes was about 400 bushels whereas the average yield per acre for all potato growers was only about 275 bushels. The fact that, since 1920, our national yields have doubled is in a good part due to the certified seed programs. Some other factors entering into this increase are of course soil fertility, soil moisture, better insecticides and fungicides. But good seed is probably the most important because, in addition to playing its part in increasing the yields, the certification of potatoes and other crops has been one of the best methods of bringing science to agriculture. Because of the rigid inspection standards that have to be met in order to grow certified seed, many mediocre or poor potato growers have learned to be very good potato growers with accompanying high yields. All of these factors are of real dollar value.

Other Important Facts

Potato certification for the production of seed has been one of the best examples of democratic, voluntary, self-regulation and control that has come about in the United States. In most states these programs have been equitable, fair, and almost entirely devoid of politics or personal graft. In most states the officials concerned with administering the certification programs have leaned over backward in their efforts to be fair. In Colorado, I know several growers who consider it a real disadvantage to be an officer or a member of the board of directors of the Colorado Certified Potato Grower's Association because they feel that the inspectors are more strict with them in an effort not only to avoid all criticism in regard to favoritism, but to be above reproach in that respect. There are, of course, some growers who have discontinued their efforts to certify seed potatoes because they thought it was too much trouble, or too expensive, or as some of them expressed it, "A lot of 'bologna.'" Many of these growers have then attempted to grow their own seed without the benefit of the certified program. In most of these cases those growers began to get lax about their "potato housekeeping" and all too frequently their yields began to slip. Other commercial growers have attempted to maintain their own seed supply by the seed plot method with a roguing program without inspection. Almost without exception, these enterprises fail to produce good seed. The diseases begin to increase, roguing is neglected in favor of other duties, and the quality of the seed is poorer than with a certification program.

There are of course some changes needed in some of the certification programs. We have had a tendency to try to make ourselves perfectionists in regard to diseases and have failed to give enough heed to degenerative conditions not normally considered to be diseases and for which we have set up no tolerances in our rules and regulations other than to speak in generalities. For instance in Colorado, the only rule we have to regulate good growing conditions, good handling methods, and good storage conditions (other than grade

standards) is the one which says "follow recommendations of the Colorado A. & M. College for good seed potato production." It is understandably very difficult to meet our needs in this connection because we are dealing with intangibles. I am speaking mainly of such factors as quality of seed planted; methods of handling seed (most seed-piece rotting that occurs has started before the seed is planted); poor seed bed preparation with resulting poor stands; poor cultivation and weeds; faulty irrigation practices, rough handling of the crop at digging time, and improper storage—all of which contribute to poor seed of poor vitality. The toleration of wet rot in considerable amounts in the storage bin for long periods of time should not be permitted. High temperatures for a considerable period of time are not good for seed vigor. Also, leaving potatoes in the ground after maturity in hot weather is not good. Excessive moisture caused by excessive irrigation during the latter part of the season no doubt reduces seed vigor. This is probably also true of soils deficient in nutrients. Within limits, all of these things are perhaps just as important as disease content. We have tended to ignore growth type and uniformity of both stand and growth in our certification programs when at the same time there are no other factors which influence the sale more than these.

Sometimes we are a little too strict from the disease standpoint. There is at least one case of our "straining at a gnat and swallowing a camel," and that is the case of ring rot and its zero tolerance, and blackleg with almost unlimited tolerance. From the time the seed is planted until the crop is marketed, blackleg causes more loss than ring rot. I can hear an audible gasp from some of our people if the suggestion is faintly breathed that we allow a trace of ring rot to carry "limited non-recertifiable" tags. Yet for years we have tolerated blackleg with its considerable losses simply because there would have been no certified seed if we had put on a zero tolerance. Every year we reject considerable acreage of otherwise good seed because it contains a trace of ring rot. Some of this seed is planted by commercial growers, but the fact that it cannot carry a "limited" certification tag prohibits much of it from being sold as seed. In too many cases this good seed goes to the table stock market when actually it may be needed as seed and is much better seed than that which some commercial growers plant. Why does this condition exist? Certainly not because our growers demand it, but because those people who are largely responsible for making the rules are afraid to ease up. There are several reasons for this: (1) we could easily ease up a little now and allow ring rot to get out of hand (it could get very bad); (2) we are afraid of the repercussions that might occur among our customers if we allowed traces of ring rot in our seed potatoes (although with the proper understanding and with unification of rules between states, this reaction would probably be negligible), and (3) we, in scientific agriculture, are all too much inclined to be alarmists and see only the unpleasant side of things. There is a reason for this, too: We urge,

beg, cajole, and persuade people to plant better seed, use more fertilizer, adopt better spray programs, adopt better methods of handling the crop, controlling weeds, etc., and then all too often find fields with 50 per cent or more disease, fields that yield 100 bushels of poor potatoes per acre while neighboring fields are yielding 700 or 800 bushels. So we know that unless we make our case pretty strong we are likely to be ignored.

Lastly, the certification values and accomplishments are not completed until the seed is sold to the commercial growers. A certified seed program can be no better than the cooperation that the commercial growers give to it. This cooperation can best be obtained by sales effort, not from the officials who enforce the regulations, but from the certified seed growers. The use of the old seed plot technique by commercial growers is probably out of date. If the poorer seed and poorer yields that these plots usually produce is considered, certified seed is cheaper to use in most years.

POTATO TUBER DISINFECTION TESTS IN WESTERN WASHINGTON

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(Accepted for publication, March 18, 1950)

Previous to the time these tests were initiated in 1943, many western Washington potato growers questioned the value of disinfecting seed pieces prior to planting. In their opinion, disinfection did not seem to give an appreciable increase in stand, nor did it seem to reduce the amount of scab, which usually is negligible, nor Rhizoctonia disease, which is widespread in this area. An experimental project was therefore initiated to determine the value of disinfection and type of seed piece on stand and yield.

Table 1 lists the materials and concentrations used in the 3-year period during which these tests were conducted.

Table 1.—*Materials and concentrations used in the seed piece treatment studies.*

Materials	Concentrations
Hydrated lime dust	....
Sulphur dust	....
Lime plus sulphur dust	50:50 mixture
Mercuric chloride	1 oz. in 7½ gals. for 90 minutes
Semesan Bel	1 lb. in 7½ gals. for 1 minute
Wettable Spergon	1 lb. in 7½ gals. for 1 minute
Ferbam	1 lb. in 7½ gals. for 1 minute
Thiram	1 lb. in 7½ gals. for 1 minute
He-175	1 lb. in 7½ gals. for 1 minute

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1943 Tests

Certified White Rose potatoes were divided into three lots and handled as follows: one lot (labeled whole) was treated before being cut into seed pieces for planting; the second (labeled freshly cut) was cut and treated the same day; whereas the third (labeled suberized) was cut and allowed to suberize for a week before treating and planting. The whole, suberized and freshly cut lots are referred to in the text as seed piece types. A plot consisted of fifty seed pieces, and each plot was replicated four times. The materials used as disinfectants in the 1943 tests were Semesan Bel, mercuric oxide, mercuric chloride, Wettable Spergon, Fermate, Tersan, sulphur, lime and lime plus sulphur. Dust applications of lime, sulphur, and lime plus sulphur were made by rolling the potatoes or seed pieces in these materials. Included in these tests was one series in which the seed-pieces were cut 2 days before planting without treatment and allowed to dry and green in the sunlight. All treatments were made on the 29th of April, and the seed pieces were planted at Puyallup on the 30th of April and the first of May. The planting was made in a sandy loam soil under optimum moisture conditions. Precipitation was .67 inch during a period of 20 days after planting.

Analyses of variance were made on stand, weight of U.S. No. 1, and total weight of tubers. The results are summarized in tables 2 and 3. There was no significant difference between the yields of U.S. No. 1 or total yields for the treatment or type of seed piece. Variation in stand due to seed piece treatment and type of seed piece was highly significant in both cases.

Table 2.—*Effect of type of seed pieces on stand and yield in 1943.*

Seed Piece Type	Ave. No. Plants June 24	Ave. Yield of U.S. No. 1 Tubers, Size A (in lbs.)	Ave. Yield of Tubers of All Grades (in lbs.)
Whole	45.1	9.6	29.3
Freshly cut	40.6	7.7	25.9
Suberized	40.6	9.0	27.4
F value	23.97**	N.S.	N.S.
L.M.D. at 5 per cent Point	1.43		

**Beyond 1 per cent Point

In comparing average stands as affected by type of seed piece, the whole tubers showed a highly significant increase in stand as compared with either the freshly cut or suberized seed pieces. There was no significant difference in stand between the freshly cut and the suberized seed pieces.

In all comparisons, a significant decrease in stand was shown when mercuric chloride was used as the seed protectant. Thiram and lime plus sulphur

were the only treatments showing a significant increase in stand in comparison with the untreated seed pieces.

TABLE 3—*Effect of disinfection of seed pieces on stand and yield in 1943.*

Treatment	Ave. No. Plants June 24	Ave. Yield of U.S. No. 1 Tubers, Size A (in lbs.)	Ave. Yield of Tubers of All Grades (in lbs.)
Untreated	41.4	7.9	27.6
Semesan Bel	43.7	9.9	27.8
Mercuric oxide	42.5	12.9	31.7
Wettable Spergon	40.4	9.2	27.9
Ferbam	43.9	8.2	29.0
Thiram	44.8	7.8	28.3
Mercuric chloride	35.9	6.9	21.2
Sulphur	42.2	7.9	24.0
Lime (hydrated)	43.1	6.9	26.4
Lime plus sulphur	44.2	9.7	31.5
F value	8.98**	N.S.	N.S.
L.M.D. at 5 per cent Point	2.61		

**Beyond 1 per cent Point

In the analysis of stand, treatment and seed piece type interaction was highly significant, indicating that seed piece type responded in a differential manner to the different treatments.

Analysis of covariance showed a correlation of .56 between stand and yield for the various treatments. This was well beyond the 1 per cent level of significance and indicates that those treatments reducing the stand through injury to the seed piece were responsible for part of the decreased yield shown by these treatments.

Some additional data were obtained in 1943 in conjunction with the main experiment. Fifty seed pieces were planted for each seed treatment. When the plants were 6 inches high, they were removed and weighed. The sulphur-treated and the untreated sets weighed the most, yellow oxide of mercury and bichloride of mercury the least, and the others were intermediate in weight. Data were not taken for the lime and lime plus sulphur sets.

Data on the amount of Rhizoctonia were also taken on these extra fifty plants per treatment and later, at harvest time, on the tubers from each treatment in the main planting. The Rhizoctonia index was low for both plants and tubers. Semesan Bel, mercuric chloride, and lime plus sulphur showed the lowest Rhizoctonia index, but the differences were not significant. There was

no appreciable difference between the results with whole, freshly cut, and suberized seed pieces as to the amount of Rhizoctonia lesions on the potatoes.

1944 Tests

Tuber-indexed Sebago potatoes were handled in a manner similar to the White Rose in 1943. They were cut for suberization on the 19th of April, treated on the 26th of April, and planted in silt loam soil at Puyallup on the 27th and 28th. Soil moisture conditions were optimum at the time of planting, and the rainfall during the next 20 days was 1.34 inches. Four applications of fifty seed pieces each were planted for each treatment. Treatments used in 1944 were mercuric chloride, Semesan Bel, mercuric oxide, He-175 and lime plus sulphur. These results are summarized in tables 4 and 5.

Table 4.—*Effect of type of seed pieces on stand and yield in 1944.*

Seed Piece Type	Ave. No. Plants October 10	Ave. Yield of U.S. No. 1 Tubers, Size A (in lbs.)	Ave. Yield of Tubers of All Grades (in lbs.)
Whole	39.3	28.7	48.5
Freshly cut	35.9	26.4	46.5
Suberized	43.0	33.5	60.0
F value	9.24**	3.61*	9.63**
L.M.D. at 5 per cent Point	6.62	5.38	6.68

* Beyond 5 per cent Point
** Beyond 1 per cent point

Table 5.—*Effect of disinfection of seed pieces on stand and yield in 1944.*

Treatment	Ave. No. Plants October 10	Ave. Yield of U.S. No. 1 Tubers, Size A (in lbs.)	Ave. Yield of Tubers of All Grades (in lbs.)
Untreated			
Mercuric chloride	35.6	23.7	43.7
Semesan Bel	41.2	33.5	55.2
Mercuric oxide	42.4	31.8	53.3
He-175	28.3	25.5	42.4
Lime plus sulphur	44.5	29.4	52.8
F value	14.84**	N.S.	5.20**
L.M.D. at 5 per cent Point	9.38		9.44

** Beyond 1 per cent Point

Table 4 summarizes the results of the analysis of seed piece type. Stand, yield of U.S. No. 1, and total yield showed significant F values. The suberized seed pieces showed a significant increase in stand and yield of U.S. No. 1,

compared with the freshly cut seed pieces. They also showed a significantly greater total yield than either the whole or freshly cut seed pieces.

Table 5 shows the results of the analysis of seed treatment. Both stand and total yield had significant F values. No treatment showed as good a stand as the untreated. Mercuric chloride and He-175 were significantly lower in stand than any of the other treatments. No treatment was as high in total yield as the untreated. He-175 was significantly lower in total yield than any other treatment except mercuric chloride. Mercuric chloride was significantly lower in total yield than any other treatment except He-175 and lime plus sulphur and, in this latter case, approached very close to significance.

There was a highly significant correlation of .84 between stand and total yield. Part of the reduction of yield is due to poor stand. Some of the treatments evidently injured the seed pieces to the extent that stand was reduced or delayed emergence resulted. Additional data, not shown here, indicate that mercuric chloride and He-175 delayed emergence.

Tubers showing the fewest Rhizoctonia lesions were obtained from plots in which the seed pieces had been treated with He-175, mercuric oxide and Semesan Bel, but the differences were not statistically significant.

1945 Tests

Although none of the materials tested in 1943 and 1944 proved superior to to the untreated lots, Semesan Bel, mercuric oxide, and lime plus sulphur appeared to be superior to the other materials. For the 1945 tests, it was decided to use Semesan Bel as a representative material and to treat only freshly cut and suberized seed pieces. Three varieties were used: certified White Rose, certified and disease-indexed Netted Gem and non-certified Sebago. The White Rose was planted at two different dates to determine if treatment would be of more value in early than in late plantings.

All plantings in 1945 were made in a silt loam soil at Mt. Vernon, Washington. Soil moisture conditions were optimum in the early planting and adequate in the late planting. The precipitation during a 20-day period after the early planting was 0.54 inches. It was 0.76 inches during a similar period after the late planting. Both plantings consisted of fifty seed pieces per plot, each plot being replicated four times. The seed pieces to be suberized were cut 2 weeks before treatment and planting. The early-planted White Rose was treated on the 16th of April and planted on the 17th. The late planted varieties —White Rose, Netted Gem and Sebago—were treated on the 21st of May and planted on the 22nd.

The early-planted White Rose showed no significant F value for treatment in stand, yield of U.S. No.1, or in total yield. Seed piece type had no significant F value except in stand. Significantly greater stand resulted from the use of freshly cut seed pieces than from the suberized seed pieces, as shown in table 6.

TABLE 6.—*Effect of treatment and type of seed pieces on stand and yield of early planted White Rose, 1945.*

Treatment		Ave. No. Plants August 9	Ave. Yield of U.S. No. 1 Tubers Size A (in lbs.)	Ave. Yield of Tubers of All Grades (in lbs.)
Seed Piece Type	Freshly cut	46.8	49.5	61.8
	Suberized	41.2	46.9	57.0
	F value	7.88*	N.S.	N.S.
	L.M.D. at 5 per cent Point	4.10	....	....
Treatment	Untreated	44.6	50.3	62.2
	Semesan Bel	43.4	46.1	56.7
	F value	N.S.	N.S.	N.S.
	L.M.D. at 5 per cent Point	....	....	....

* Beyond 5 per cent Point

The late planting, which included White Rose, Sebago and Netted Gem, showed no significant F value for treatment on stand, yield of U.S. No. 1, or on total yield. (Table 7.) Seed piece type and variety had a significant F value

TABLE 7.—*Effect of treatment and type of seed pieces on stand and yield of late planted White Rose, Sebago and Netted Gem.*

Treatment		Ave. No. Plants August 9	Ave. Yield of U.S. No. 1 Tubers Size A (in lbs.)	Ave. Yield of Tubers of All Grades (in lbs.)
Seed Piece Type	Freshly cut	45.0	22.7	30.9
	Suberized	40.0	17.8	23.8
	F value	23.75**	5.81*	9.87**
	L.M.D. at 5 per cent Point	2.0	4.1	4.4
Treatment	Untreated	43.5	21.2	28.3
	Semesan Bel	41.5	19.2	26.4
	F value	N.S.	N.S.	N.S.
	L.M.D. at 5 per cent Point	....	....	....
Variety	White Rose	42.2	29.1	37.2
	Sebago	38.8	20.6	25.1
	Netted Gem	46.4	11.0	19.8
	F value	19.08**	26.19**	21.70**
	L.M.D. at 5 per cent Point	2.5	5.0	5.4

* Beyond 5 per cent Point
** Beyond 1 per cent Point

in all three analyses. Freshly cut seed pieces produced a significantly greater stand, yield of U.S. No. 1, and total yield compared with the suberized seed pieces. Netted Gem was significantly better in stand than either White Rose or Sebago.

Covariance analysis gave a non-significant correlation of .36 between stand and total yield, indicating that Semesan Bel does not injure the seed pieces to the extent of causing a reduction in stand.

Although, on the average, the seed pieces of the Sebago variety had only about one-fifth as many Rhizoctonia "lesions" per tuber as White Rose at planting time, each had about the same number of lesions when harvested. The Netted Gem seed pieces exhibited about as much infection as White Rose when planted, but considerably more when harvested. The Semesan Bel treatment did not control Rhizoctonia; in fact, the Rhizoctonia index was lower for the untreated than for the treated sets in most cases, but not significantly so.

A 3-year summary, considering only the non-treated and the Semesan Bel treatment on freshly cut and suberized tubers, showed no significant "F" value for treatment or seed piece either in stand or total yield. An analysis of covariance for the 3-year data showed no significant correlation between stand and yield for the Semesan Bel treatment, thus confirming the results of the covariance analysis on the 1945 data.

Discussion and Summary

The results of the 3 years of tests show that under the conditions encountered in these experiments no increase in yield can be expected from treated potato seed pieces, regardless of the planting date. There were no differences in yield of U.S. No. 1 potatoes that could be attributed to treatment in any of the four plantings over the 3-year period. There also were no differences in total yield because of the treatment in any of the four plantings, except the 1944 planting. In this case the untreated plot was higher in yield than the treated plots. Mercuric chloride and He-175 were lower in yield than the other treatments, as well as the untreated plot.

The greatest differences were observed in stand count. Differences in stand count were significant in the first 2 years' trials both for seed piece type and for treatment. In 1943, both Thiram and lime plus sulphur gave a significant increase in stand count compared with the untreated check, but this did not result in an increase in either the yield of U.S. No. 1 or in the total yield. Thiram was not included in the 1944 tests, but lime plus sulphur did not give a significant increase in stand compared with the untreated check in 1944. Mercuric chloride showed a significant decrease in stand in comparison with the untreated check and with all the other treatments in 1943 and again in 1944. He-175 (disodium ethylene bisdithiocarbamate) was also significantly

lower in stand than all other treatments, including the untreated check in 1944, the only year it was tested. In 1945, treatment with Semesan Bel had no effect on stand count, compared with the untreated check. This was true for the comparison of Semesan Bel with the untreated check for all four plantings during the 3-year period.

It is evident that in these experiments none of the treatments used consistently gave better stands than the untreated check plots. In no treatments did a reduction or increase in stand result in a significant difference in yield of U.S. No. 1 or total yield, except in the case of mercuric chloride and He-175 in which a significant reduction in stand was expressed as a significant reduction in total yield, as compared with the untreated plot. In this case, there was no significant difference in yield of U.S. No. 1 tubers.

Seed piece type was significant in all four plantings as regards stand. However, there was no consistency between the different years. In 1943, the whole tubers had the best stand; in 1944, the suberized seed pieces had the best; and in 1945, in both the early and late plantings, the freshly cut seed pieces had the best stand. In all four plantings during the 3-year period, the seed piece type which produced the best stand also produced the highest yield of U.S. No. 1 tubers and the largest total yield of tubers although the differences were only significant in the 1944 planting and in the late planting in 1945.

Since treatment was not a factor in stand or yield, the differences exhibited by seed piece type from year to year probably depend upon the particular environmental factors encountered during the period from planting to emergence such as soil type, soil temperature and soil moisture content.

The results presented herein support the conclusions from the cooperative tests of the American Phytopathological Society (2) that disinfection of seed potatoes is frequently not profitable. Fusarium seed piece decay was not encountered in these tests. In stocks where its presence is known or suspected, a disinfectant should probably be used. Cunningham and Reinking (3) found the following materials effective in controlling such decay when used as instant dips: yellow oxide of mercury (1 lb. in 30 gals of water) and Semesan Bel (1 lb. in 7½ gals. of water). Blodgett and Rich (1) suggest the use of Ziram (1 lb. in 50 gals of water for 1 minute) for potato seed disinfection in Washington.

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AN IMPROVED TECHNIQUE FOR GROWING POTATOES IN SOLUTION CULTURES.

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Problems relating to the nutrient requirements of the potato crop have engaged the attention of agronomists and biochemists in this country and in Europe for many years. Much of this work has been done in the field, but at the same time there has existed an interest in and a need for a feasible technique for growing potatoes under conditions permitting a high degree of nutrient control. This need now seems to be greater than ever, since the use of fertilizer on the potato crop is markedly increasing, and attention is being directed more than ever toward research problems related to the nutrition of the crop.

It is possible to grow potatoes in conventional sand, gravel, or solution cultures; but ordinarily certain difficulties peculiar to potato culture are encountered, and these usually must be overcome before normal plants and tubers can be produced. The first of these difficulties arises from the fact that potato tubers are produced below the surface of the ground, and therefore require a suitable, light-free environment for their development. Moreover, with solution cultures, it is necessary to provide additional means for the mechanical support of both the tubers and the plant. A further difficulty occasionally encountered, which is more serious where studies are to be made on the tubers, is the uncertainty of tuber formation under adverse conditions. Sometimes for no apparent reason the plants fail to produce any tubers at all, or at best form very small abnormal ones. In many of these instances water-logging of the medium is directly or indirectly the cause. This is apt to be the case with sand cultures where the nutrient solution is either poured on or pumped up. However, water-logging can also occur in gravel cultures when the gravel used is small; but as a rule gravel cultures are less objectionable for potatoes because of water-logging than are sand cultures. A modified solution culture method that avoids many of the objections of other methods has been devised by the writer. Its use, both in the greenhouse and outdoors, has given very satisfactory results, producing ideal growth of both plants and tubers. The purpose of this paper is to describe the equipment and technique of this method, illustrate its operation, and indicate briefly its usefulness.

The equipment required is similar to that described elsewhere (1) and is illustrated in figure 1. Each unit consists of a 30-gallon earthenware tank,

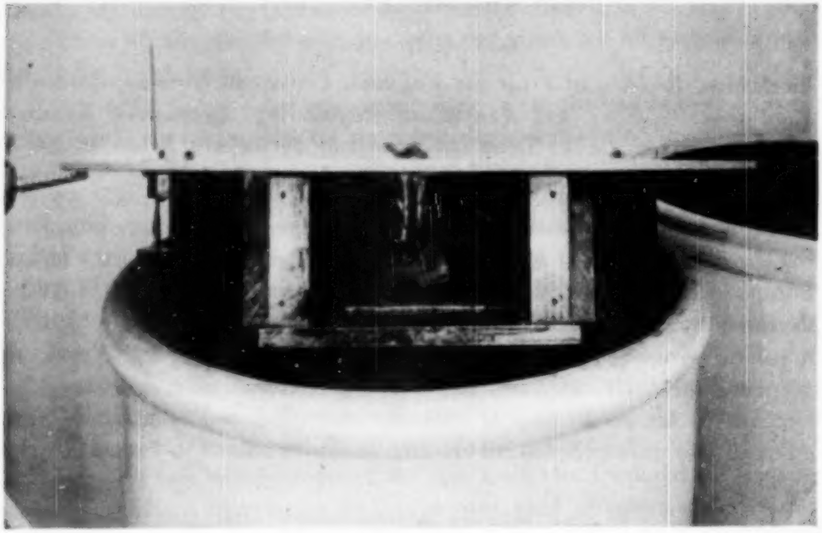

Figure 1.—Method of planting potatoes and equipment, including tuber chamber with sphagnum moss partly removed, plastic screen support, and float gage.

vitrified on the inside and supplied with a plywood or masonite cover with a wooden compartment attached to the under side. In the bottom of this, the tuber compartment, there is a 5-inch circular opening covered with a $\frac{1}{4}$-inch mesh screen of plastic material such as nylon or lumite. Support for the plant is provided by this screen, which also allows the roots access to the solution culture below. The tuber compartment, which is 4 inches deep and 15 inches square, is removable, being suspended from the tank cover by wood screws or bolts with wing nuts. Two sides of the tuber compartment can also be made removable to permit access for observing tuber growth or for other purposes. When established, the plant grows through a 2-inch opening in the tank cover with its tubers developing in this compartment and its roots in the nutrient solution about 1 inch below the plastic screen support. The solution is continuously aerated through perforated glass tubing at the approximate rate of 6 liters of air per hour; and the solution level is regulated by additions of water according to need as indicated by a calibrated float gauge.

In early trials no material of any kind was used in the tuber compartment, but under these conditions, with the tuber stolons exposed to the air, tuber formation proved to be very uncertain. Since it is known that unusual temperature changes are likely to interfere with normal tuber development (2),

an attempt was made to overcome this difficulty by keeping the temperature in the tuber compartment lower than the air temperature and as uniform as possible. To do this the tank covers were painted with aluminum paint to reflect heat rays, and a non-conducting material, sphagnum moss, was packed loosely in the tuber compartment, as you will see in figure 1.

When an experiment is started, the potatoes can be conveniently planted in somewhat the usual manner by placing an unsprouted seed-piece on the screen directly under the opening in the cover and surrounding it with moist sphagnum moss. This procedure, although convenient, was found objectionable because the young sprouts do not always grow directly through the opening in the cover, thus causing some variation in the plants. Experience has indicated that a better planting procedure is to sprout the seed pieces first, in moist building sand or a compost soil, and then to select uniform plants for transfer to the tanks when the sprouts are about 5 inches long. When this procedure is followed, the young plants, as a rule, suffer practically no set-back in growth because of the moist condition maintained by the sphagnum moss. After a few days on the tanks the roots of the plants normally develop sufficiently to reach the nutrient solution just below the screen and then vigorous growth usually takes place.

TABLE 1.—*Calculated composition of nu:rient solution.*

Salt (c. p.)	Nutrient	P.P.M.	Milli-equivalents per Liter of Solution
Calcium nitrate	Ca NO_3	180.36 558.07	9.00 9.00
Ammonium phosphate, dihydrogen	PO_4 NH_3	189.96 34.06	6.00 2.00
Potassium chloride	K Cl	100.00 90.69	2.55 2.55
Magnesium sulfate	Mg SO_4	55.94 220.94	4.60 4.60
Boric acid	B	0.094	0.0258
Manganous sulfate	Mn SO_4	0.065 0.115	0.0024 0.0024
Copper sulfate	Cu SO_4	0.0509 0.0768	0.0016 0.0016
Zinc sulfate	Zn SO_4	0.0457 0.0668	0.0014 0.0014
Ferric citrate	Fe	3.0	0.1612

The type of nutrient solution ordinarily is governed mainly by the problem under study; however, the solution formula given in table 1 has been found

to produce excellent growth of tops and tubers (Fig. 2), and therefore it generally has been used as a control for making growth comparisons.

Figure 2.—Size and set of tubers obtained after 110 days. Variety: Katahdin. (Photograph approximately one-sixth actual size)

As growth increases, the foliage of the plants can be supported, if necessary, by strings fastened to a 1/4-inch dowel, 24 inches long, inserted in a hole bored in the tank cover. At any time during the growth of the plant the nutrient solution can be sampled simply by raising the tank cover; and, if desired, the entire solution can be quickly removed by suction and renewed without more than momentarily disturbing the plant. Likewise, during the growth period the tubers may be uncovered, measured, examined, or treated without in any way affecting the roots of the plants or their nutrient uptake (Fig. 3). The importance of these advantages will be recognized because they enable the investigator to make studies on the tubers and roots of the potato in a manner that otherwise would not be possible without seriously affecting the growth of the plant.

In view of the high degree of nutrient control possible with the modified solution culture method and the excellent growth attainable, it is now possible to pursue several lines of investigation in a manner not heretofore feasible with other methods. Problems that relate to the possible effects of nutrition

in altering the susceptibility of potatoes to certain diseases, especially some soil-borne diseases affecting the tubers, can now be studied with the improved technique in a way that will enable complete separation of the nutrition of the host from that of the disease organism. Similarly, the effects of the reaction

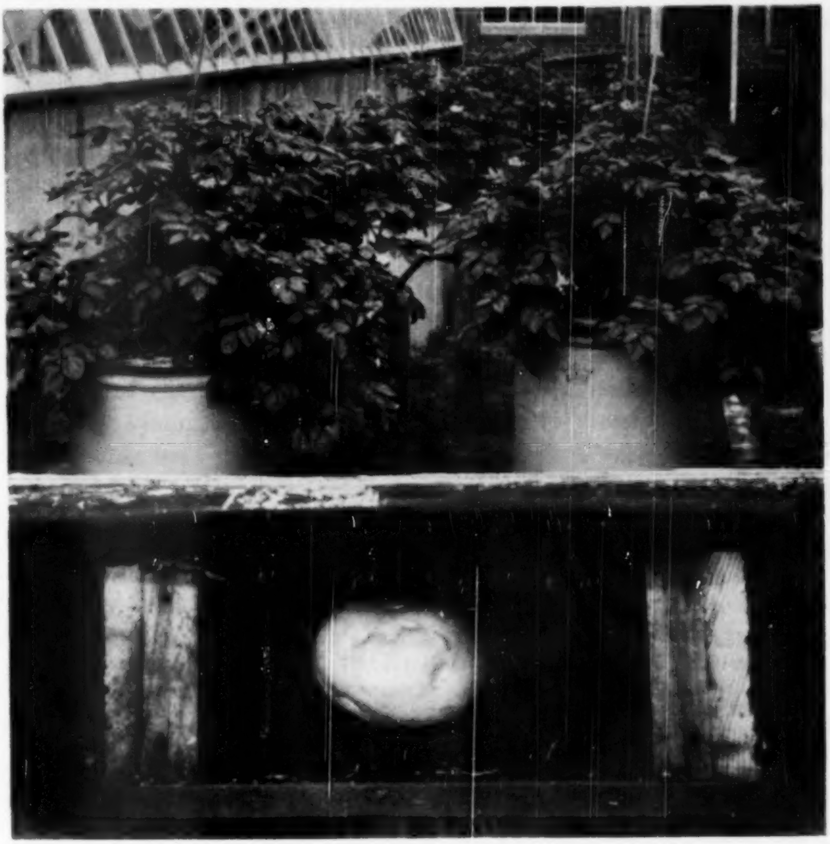

Figure 3.—Excellent growth of tops obtained outdoors and individual tuber exposed for observation during growth. Variety: Katahdin.

(pH) on the nutrient uptake can be studied, but in closer detail than has been possible heretofore, owing to the ease with which the solution can be sampled and adjusted. Comprehensive studies on the relationship of plant nutrition to insect injuries are also possible with the improved apparatus merely by providing a screen or plastic covering fastened to the tank cover and containing both insects and plant tops. If a plastic cover is used, similar studies may be made on the effects of nutrition in altering the susceptibility of the tops of the

plants to certain foliage diseases. For example, under suitable conditions spore suspensions of organisms such as *Phytophthora infestans* can be sprayed on the vines under the plastic covers to test the relative susceptibility of plants receiving different amounts and kinds of nutrients. Visible symptoms of nutrient deficiencies in the tops and the tubers can also be conveniently studied in detail and photographed during successive stages of development.

At present the improved solution culture technique is being used to study the relationship between the nutrition of the potato plant and its susceptibility to common scab. It is also being used in the greenhouse to evaluate the practice of tuber removal, together with high-potash nutrition in the production of true seed in otherwise non-fertile potato varieties.

Like most plant research conducted under partial control, that done with solution culture technique is necessarily limited to a relatively few plants. However, the improved solution culture technique described enables the investigator to make greater use of what might be termed "the clinical approach" studying progressively the effects of treatment on individual plants as a function of time. This approach to biochemical problems related to the nutrition of the potato it is believed offers greater promise of results than field-plot technique which for similar problems is dependent upon successive sampling with multiple plant samples. If this belief is proved to be right, it seems only reasonable to expect that further applications of the improved culture technique will develop with continued use.

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II. BREEDING POTATOES WITH RESISTANCE TO THE COLORADO BEETLE

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The first suggestions for breeding of a potato, resistant to the Colorado beetle *Leptinotarsa decemlineata,* we owe to *Feytaud, Trouvelot* and other French scientists. Fifteen years ago they observed a Mexican wild potato, *Solanum demissum,* to be an unsuitable feeding plant for this insect. The larvae cannot develop normally in its foliage and they do not eat much of it. This observation led to extensive examinations of several Solanaceae, which were undertaken in amicable collaboration of French and German scientists in France in 1936. On the basis of these preliminary researches we were able to start the breeding for resistance in 1941 in a specially installed beetle station at the Rosenhof near Heidelberg.

1. Methods of Selection

The simplest test is, to grow the potatoes in question in the open field in an area, where many beetles and larvae are present, omitting every control of the Colorado beetle. The damage caused on different varieties and special host-insect relations can be observed and noted. It is of great importance to be near a field that was heavily infested in the previous year, wherefrom the immigration of hibernated beetles can take place easily. The disadvantages of this method are the inequal distribution of insects and larvae among the plants and the long duration of the test over the whole growing season. Moreover, as experience has shown, periods of bad weather including falls in temperature, may retard the development of the insect so much as to render the differences of the damage, found in the field, insufficient.

Because of the quoted disadvantages there were developed some laboratory methods, all based on forced feeding of larvae under controlled external conditions. Judging the resistance of the potatoes, the foliage of which was fed, two principles were watched: (1) quantity eaten as an indication of the damage to be expected in the open field; (2) death-rate of larvae in per cent and retarded development. In most cases little consumption, high death-rate, and retarded development in connection with low weights of larvae are combined on resistant plants.

At our Colorado Beetle Station the tests for resistance at present are carried out in the following manner: The potato seedlings are grown in the greenhouse in boxes until reaching a height of $2\frac{1}{2}$ inches (6 cm). Then 3 to

5 larvae, which immediately before had left their eggs and have had no other food, are put on each plant with a little brush, and after 3 to 6 days the seedlings are counted to determine how many have been badly eaten and how many have suffered little damage or none at all. Only the latter are potted and later on planted on the field in order to be selected for other good characters. With this rough method several mistakes happen, which are partly corrected by further tests. For this purpose the harvested tubers are grown in a cage with thousands of beetles in the following year, where they are watched under heavy infestation with imagoes and larvae. In addition, young larvae recently slipped out and without any food so far, are fed on their foliage in a hygrostate ("Dahlemer Insektenschale"), while development and percentage of mortality of larvae are noted. Such observations through some years in relation to controls on *Solanum tuberosum* allow us to judge the resistance to the beetle.

Biological tests are exhibiting failures, of course, which are explained by different reactions of plants and animals. The results of the tests are influenced by fluctuations of the vitality of larvae as the consequence of the weather, and the state of health of the feeding plants. Our methods of testing prove successful only if they are all practiced one after the other on the same plant material and repeated several times, whereas a single test easily offers wrong conclusions, as diseased larvae, for example, may pretend resistance. Improved testing methods on a chemo-physical basis are probably possible only after the stuff responsible for the resistance of the solanaceae in question is known.

Shortly the test for resistance is carried out in three consecutive phases: (1) Selection of resistant seedlings by repeated feeding trials in the laboratory. (2) Test of the clones of resistant seedlings in a gauze cage under a very heavy infestation of beetles. 3. Observations of the infestation in the open field.

2. Resistance in Cultivated Potatoes

In France extensive field trials were made with several varieties of our cultivated potato. Furthermore, the trials covered primitive species of South America including 24-chromosomic potatoes which are grown by the Indians such as *S. rybinii*, *S. phureja*, *S. chaucha* and others. Little differences of reaction were noticeable, which are partly caused by the habit of certain varieties. A growth habit like that of *S. andigenum* with many stems and relatively little foliage is not so well liked by the beetle as plants with rich foliage. Compact structure types are favored for depositing the eggs and consequently are especially visible eaten off by the many larvae. With varieties exhibiting quick development, when young and with good regenerating capacity, the depression of yield is relatively low. According to feeding trials, however, all cultivated varieties are suitable host plants for *Leptinotarsa*

decemlineata, for on them the development of larvae is normal and the mortality is low. Therefore, it is impossible to base the breeding for resistance against the Colorado beetle on *Solanum tuberosum* and other South American cultivated potatoes.

3. Resistance in Wild Species

The trials on wild species of potatoes gave more promising results. The invasion into the Bordeaux area by the Colorado beetle ,which was noticed in 1923, stimulated French entomologists to intensive studies on the biology of this insect. In the big family of the Solanaceae besides *S. tuberosum* they found several species which were suitable as host plants for *Leptinotarsa decemlineata*, as *S. rostratum*, *S. dulcamara*, *Atropa belladonna* and others. On the other hand among tuber-bearing Solanaceae they found some plants on which the larvae of the Colorado beetle did not develop normally. Special interest was aroused by the resistance of *S. demissum Klotzschii*, which was studied eagerly about 1935. At this time, *S. demissum* was within the sphere of scientific potato breeding because of its outstanding resistance to *Phytophthora infestans*. Many hybrids between this wild species and *S. tuberosum* had proved to be resistant to late blight. Thus it was obvious, to try and achieve resistance to the beetle, too, in our commercial varieties by crossing with this species.

The spread of the Colorado beetle over Western Europe was watched with attention in Germany. All measures of control could not stop its way to the east. Through the kindness of the competent French authorities and German scientists we were enabled, in collaboration with French scientists at Versailles and Ahun (Prense), to examine the basis of breeding for potatoes with resistance to the beetle. Their observations on wild potatoes are recorded in several publications and may be summarized as follows:

1. Resistance of *S. demissum* as concluded from physiological trials, is probably due to chemical substances (Busnel, Trouvelot and Chevalier).

2. The larvae react more readily than do the beetles on the foliage of resistant plants, and therefore are preferred for tests (Schaper, Sellke).

3. Judgment of resistance is based on the quantity of leaves eaten, development of the larvae, and death-rate of larvae (Trouvelot, Mueller-Boehme, Schaper, Sellke).

4. Besides *S. demissum* some other wild species exhibit high resistance to the beetle (see table).

5. Some species are uniform, others are heterozygous, that is single plants show a different grade of resistance (Schaper, Sellke).

6. In some cases the tested hybrids between resistant wild species and *S. tuberosum* showed a high resistance, but did not reach the grade of resistance of their wild parents (Trouvelot, Schaper, Sellke).

TABLE 1.—*Resistance to the Colorado Beetle in most important wild species.* (After Trouvelot, Muller-Boehme, Schaper, Sellke and Torka)

Name of Species	General Judgment of Resistance	Larvae	Beetle	Remarks
S. demissum	Very resistant	++	+—	Different samples differ in resistance
S. polyadenium	Very resistant	++	++	
S. henryi	Resistant	+	++	
S. jamesii	Very resistant	++		
S. milanii	Very resistant	++	++	
S. chacoense	Susceptible to Very resistant	(—)++	(—)++	Great differences within the species
S. macolae	Resistant	+	+—	Heterozygous
S. cartarthrum	Resistant	+—	+—	Heterozygous
S. commersonii	Resistant	+—		Probably heterozygous
S. caldasii	Resistant	+—		
S. gibberulosum	Resistant	+—		Heterozygous
S. cordobense	Susceptible ?	—?		Eventually heterozygous
S. verrucosum	Susceptible ?	—?		Eventually heterozygous

Remarks: + = Moderately resistant
++ = Highly resistant
— = Susceptible
+— = Heterozygous for resistance

The following species are susceptible: *S. acaule, S. ajuscoense, S. antipoviczii, S. Aracc papa, S. cardiophyllum, S. fendleri, S. garciae, S. neoantipoviczii, S. parodii, S. vallis mexici, S. wittmackii.*

In these preparatory investigations in France two German Research Centres took part, the Biologiche Reichantalt at Berlin-Dahlem (Schwartz, Mueller-Boehme, K. O. Mueller and Sellke) and the Kaier-Wilhelm-Intitut für Zuchtungsforchung (Schaper). After the outbreak of the war the research work that had been started was carried on in Germany. At the Biologische Reichsanstalt in 1941 at Kruft/Eifel (now Muehlhausen/Thuringia) a Colorado Beetle Research Station was established. Here, mainly, different strains of *S. demissum* and their hybrids with *S. tuberosum* were tested for resistance to the beetle. At the Colorado Beetle Station of the filial station of the Max-Planck-Institut für Zuchtungsforschung in Baden, tests also were started in 1941. These tests consisted of: (1) Examinations on further

* Since March 1948 the Kaiser-Wilhelm Institut für Zuchtungsforschung has changed its name and now reads as follows: Max-Planck-Institut für Zuchtungsforschung (Erwin-Baur-Institut).

wild species, which had not yet been tested; (2) examinations on the resistance of hybrids between wild species; (3) detailed studies on *S. chacoense*, the resistance of which had not been evident in France; and (4) detailed studies on transmission of genes for resistance from wild species to hybrids with *S. tuberosum*.

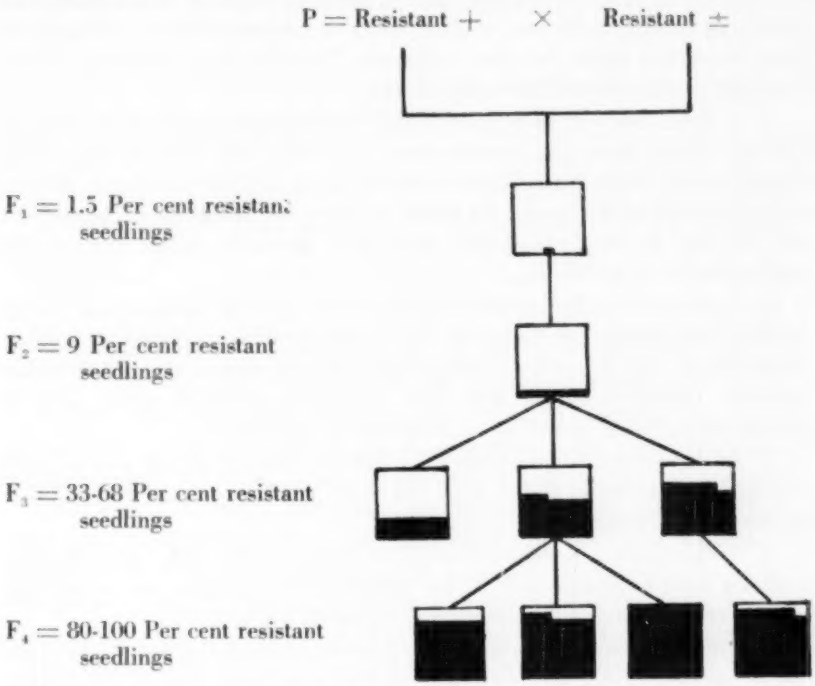

Figure 1.—Augmentation of the percentages of resistant seedlings of *S. chocoense* by inbreeding.

In the tests for resistance of wild species the following results were discovered: susceptible, *S. wittmackii*, *S. parodii* and *S. boergeri*. The Mexican *S. cardiophyllum* in the open field suffers little damage by the beetle and its larvae. Probably the low infestation is caused by the fact that the animals cannot get a hold on the even surface of stems and leaves and therefore easily fall down. But then forced to eat the leaves of *S. cardiophyllum*, the larvae develop normally. Within *C. gibberulosum* and *S. catarthrum* on different plants a different degree of resistance was observed and it may be possible by systematic selection to find plants with high resistance. In the same manner it is possible to increase the resistance of *S. macolae*, as tests of the offspring of seedlings have shown.

Moreover, wild potatoes, with their complete resistance, offer promising

material for other breeding aims as resistance to frost, Phytophthora and viruses. As far as possible, genes for the different characters of resistance will be introduced into one and the same variety. By hybridization of wild species with *S. tuberosum* apart from genes for resistance, many undesirable features of primitivity are transmitted, which must laboriously be eliminated in later generations. In order to achieve several breeding aims by introducing wild genes only once, hybrids were at first produced between different wild species. These were then tested for their resistance. Tests for their resistance to the Colorado beetle gave the following results:

1. *S. demissum* x *S. chacoense*: These hybrids were produced in 1942 by Stelzner. They have 48 chromosomes and, for this reason, are easily crossed with *S. tuberosum*. Eleven tested F-plants, without exception, showed high resistance to the beetle. On many of them the death-rate of larvae was 100 per cent. In the F_2-generation there were also some plants affecting the high mortality of the larvae.

2. *S. chacoense* x *S. macolae*: These hybrids, with 24 chromosomes, partly exhibit good resistance to the beetle. The mortality of larvae differs with different seedlings. The injury by Phytophthora and the viruses was considerable. However, treatment of the seed with Colchicine produced plants with 48 chromosomes, which could be crossed with *S. tuberosum*.

3. *S. chacoense* x *polyadenium*: The hybrids of these species showed good resistance to the beetle in the tests, but their growth was retarded and they produced no flowers.

4. *S. demissum* x *S. verrucosum*: Two hybrids of this kind with 48 chromosomes were produced in 1941 by Stelzner. One of them was remarkable by its increased vitality and its modest resistance to the beetle.

The intensive investigation of *S. chacoense* covered the years 1942-1947 and comprised 33,000 wild seedlings. 16,000 were originated by self-pollination (achieved by grafting of *S. chacoense* on tomato) and 17,000 by cross-pollinations. The wild species *S. chacoense Siambon* contains plants which are completely susceptible, plants with slight and plants with high resistance. The tests of the offspring of such plants with high resistance obtained by self-pollination disclosed that they are heterozygous and split into plants with different degrees of resistance. By systematic inbreeding and selection, strains could be built up, the resistance of which was almost homozygous.

Susceptible and modestly resistant lines of *S. chacoense* may produce a progeny with a higher degree of resistance to the beetle. Accordingly even susceptible parents may contain genes for resistance These results suggest a quantitative heredity and the existence of several factors for the resistance to the beetle. Only with plants, in which they are combined, resistance becomes manifest.

A special advantage of *S. chacoense* over *S. demissum* consists in its ex-

tremely high effect of deterring larvae and beetle from eating. This goes as far as to make larvae and beetles prefer starvation to feeding on the leaves offered. All observations of the behavior of the insect indicate the presence of a deterrent stuff, the nature of which is unknown, however. The only substances known to cause resistance, is "Demissin," a Solanin-like product found in *S. demissum*, isolated by Kuhn. In *S. chacoense* there was no "Demissin" to be found.

TABLE 2.—*Successful crosses of beetle-resistant wild species with S. tuberosum.*

Mother	Father	Mother	Father
S. tuberosum	*S. demissum*	*S. demissum*	*S. tuberosum*
S. tuberosum	*S. polyadenium* (with 4n only)	*S. chacoense*	*S. tuberosum*
S. tuberosum	*S. chacoense*	*S. macolae* (with 4n only)	*S. tuberosum*
S. tuberosum	*S. catarthrum*	*S. catarthrum*	*S. tuberosum*

PRACTICAL APPLICATION OF THE THEORETICAL RESULTS.

1. *Hybrids of S. chacoense* x *S. tuberosum*. The first systematic crosses were carried out in 1942 with wild clones, the resistance to the beetle of which was very heterozygous as their progeny disclosed. From 1942 to 1947 a total of 112,000 hybrid seedlings was grown and harvested. Eight hundred F^1-plants were susceptible without exception. Recently it has been possible, after new hybridization, with almost homozygous forms of *S. chacoense* to cause or bring about in the first generation a slight mortality of larvae. In the F_2-generation the resistance happened more frequently, but never reached that of the wild parents. After back-crossing of hybrids with resistance with *S. tuberosum* it was never possible to find high grade resistance. After back-crossing with resistant *S. chacoense*, on the other hand, the resistance was considerably increased.

For practical breeding these results indicated, that almost without exception self-pollinations and cross-pollinations within hybrids with resistance are necessary, in order to maintain resistance in the hybrids and that care must be taken not to lose it in further crosses. For this reason back crossing with *S. tuberosum* is out of question, because it is very difficult to produce hybrids with resistance, which at the same time produce tubers in quantity and quality comparable to those of our commercial varieties. Clones with a good yield capacity frequently show only slight resistance, those with a high resistance are mostly disappointing because of low yields and long stolons. Our most promising strains with medium to good resistance to the beetle produce tubers of a weight that is about 60 per cent of that produced by a standard variety.

A serious disadvantage with all *chacoense*-hybrids is their extreme susceptibility to *Phytophthora infestans*, which is to be counteracted by crossings with late-blight resistant strains of our Institute.

2. Hybrids of *S. polyadenium* x *S. tuberosum*:

Stelzner in 1942 succeeded in crossing *S. tuberosum* and *S. polyadenium*. In the summer of 1943, 350 hybrid-seedlings were grown, two of which were striking by the good formation of tubers, whereas most of them were characterized by the formation of stolons only. At present all *polyadenium-tuberosum*-hybrids of our Institute are derived from these two F^1 plants.

Tests of these for resistance to the beetle gave the following results: Both F_1-clones were as susceptible as *S. tuberosum* and were especially heavily infested with beetles and larvae in the open field. Four hundred F_2-seedlings were almost as susceptible and only one plant exhibited, in tests over several years, a higher death-rate of larvae than *S. tuberosum*, and it also showed good field-resistance. This makes it evident that back-crosses with cultivated varieties were also susceptible. Back-crosses with polyploid *S. polyadenium* produced seed in 1948 for the first time and nothing can be said yet about their resistance to the beetle.

Resistance to the beetle in *polyadenium*-hybrids to date is insufficient and must be increased considerably. A special advantage of these hybrids is their surprisingly good yielding capacity. They frequently give returns that can be compared with those of European varieties.

Summary

1. A short historical review is given pertaining to the European researches of the host-insect relations and in the phenomenon of resistance of wild species of *Solanum*.
2. The methods for testing and selection of resistant wild species and hybrid clones are also described.
3. A list of tested wild species, together with their behavior towards the beetle is given.
4. The behavior of F_1 hybrids of different wild species and of hybrids of *S. chacoense x S. tuberosum* and of *S. tuberosum x S. polyadenium* (4n) is described.

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SECTIONAL NOTES

Indiana

The potato situation in Indiana is rather quiet. We have a few people who were very much disgusted with the quotas set out this past year and, for some reason or other, some one is not greatly interested in having the growers in Indiana produce enough potatoes to take care of our needs. It seems as if they would rather have them imported from some other locality and, frankly speaking, we cannot say too much about the quality of imported potatoes. Our growers are cooperating with the various programs inasfar as possible, and we have prospects of a very good crop. We have had sufficient moisture and good control of both insects and diseases. Our crops, as a whole, look very promising.

The early potato harvesting operations are starting in southern Indiana—the quality is excellent and the yields are much improved compared with those for the past several years. Most of the potatoes from the early harvest will be used locally or in nearby cities—some going to Cincinnati, Lousville and St. Louis, although there is a ready market at home.—W. B. Ward.

Nebraska

The situation in Nebraska at this moment is rather difficult to describe. We have had one of the driest springs for many years. The reports from various parts of our territory are not very encouraging because many fields are not showing good stands. We estimate fair stands, however, because some soil moisture was retained from our winter snows. The acreage of commercial plantings is slightly heavier than a year ago, but Nebraska has been going downhill for some time, so that we are considerably below the ten-year average. Our certified acreage compared with that of last year is six to eight per cent less.

As far as we can tell, no marketing agreement will be in effect for the western Nebraska and the eastern Wyoming section in which the major late crop is grown. Central and eastern Nebraska, which is an early deal, is going to vote and the results, of course, will not be known for some time.—Marx Koehnke.

New York

New York growers are planting about the same acreage as last year. There probably is less acreage allotment compliance but on the other hand many growers have voluntarily reduced their acreage considerably.

A Marketing Agreement hearing was held in May and a referendum is expected in July. There seems to be very little interest at the moment one

way or the other as growers have just finished planting, but we know that they are watching the outcome of referenda in other places.

There will probably be a slight increase in certified seed acreage and there has certainly been a big planting of extra good seed. There has been a noted improvement in tuber unitting and other methods of securing foundation quality.

The Empire State Potato Club will hold its Annual Summer Field Day on the 3rd of August at Chafee, Erie County, New York. This will undoubtedly be a big event as many demonstrations of machinery and other equipment, plots conducted by various departments from the State College, as well as many local attractions are expected to draw visitors from surrounding states and Canada.—H. J. Evans.

Oregon

The Klamath Potato Growers' Association (a growers' group) completed their trial run on marketing potatoes in consumer packages. They marketed a total of four cars in a 10-pound specially built bag known as the Toter bag. A card placed in the bag asked consumers for their opinion. A large number of replies were received and 99 per cent were highly favorable. This was particularly important in that the potatoes were not selected on a super-quality basis but were a good sound representation of the great bulk of local potatoes ranging from 4 to 10 ounces with no allowance or tolerance in the grade. They were shipped in pasteboard containers holding 8 of the 10-pound packages. Growers are now considering with dealers the next step in this development. The growers receive from $15,000 to $20,000 a year from a special tax on their product through the Oregon Potato Commission for the purpose. The most noteworthy accomplishment to date seems to be focusing the attention of dealers on special consumer containers of a good sound quality potato. Further progress in this type of marketing is expected from the 1950 crop.

The 1949 crop was cleaned up early in May with some up turn in prices during that month. The acreage for 1950 now seems to be about the same as that produced in 1949. The crop is now up and coming along in good shape, although, some seed piece rot occurred on light sandy soils because of temperatures and drying winds at planting time.—C. A. Henderson.

Province of Ontario

The South-Western Ontario Early Potato Marketing Board at a meeting on the 26th of June decided that digging would not commence until the 3rd of July. This is later than usual.

The sizing of the early crop is good, and average yields are reported slightly above normal.

This year the local Board shall be the marketing agency and no grower

shall sell or deliver new potatoes produced in the area except through the medium or of the direction of the marketing agency. The Board has the power to establish price, to prohibit the marketing of any grade or size of new potatoes and to fix harvesting, digging and shipping quotas and to establish harvesting, digging or shipping quota committees.

Prior to the application of grower quotas, supplies of new potatoes shall be delivered to licensed dealers on a percentage basis in accordance with the sales, acreage and production figures of the individual dealers during the seasons 1948 and 1949 or as directed by the Board.

The area under control consists of the counties of Essex and Kent and the Township of Aldborough in the county of Elgin.

The controlled acreage registered will total approximately 6600 acres for 1950, a drop of about 1000 acres.

The crop is controlled until the 1st of September, 1950.

All acreage is registered, and inspection for all is provided. There are many details relative to producers and dealers.

In connection with late potatoes, the following excerpts from Agricultural Representatives' reports are typical:

North Simcoe—Acreage limited and growth slow.

Renfrew—Conditions are still fair, but below average for this time of year.

Grenville—Growth good—insect damage heavier than usual.

The condition of the main potato crop at the present time in Northern Ontario is below normal, but is reported as most satisfactory in practically all counties of Southern Ontario.

The acreage planted to late potatoes is approximately the same as a year ago in Old Ontario, but it is somewhat lower in Northern Ontario because of the frequent rains during June which interfered with cultivation.

Flea beetles have been giving the most trouble.

Old crop potatoes are nearly "cleaned up."—R. E. Goodin.


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